INTERACTION TECHNIQUES FOR FLEXIBLE DISPLAYS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from U.S. Provisional Application Ser. No. 60/788,405, filed on Mar. 30, 2006.

[0002] Each of the applications and patents cited in this text, as well as each document or reference cited in each of the applications and patents (including during the prosecution of each issued patent; "application cited documents"), and each of the U.S. and foreign applications or patents corresponding to and/or claiming priority from any of these applications and patents, and each of the documents cited or referenced in each of the application cited documents, are hereby expressly incorporated herein by reference. More generally, documents or references are cited in this text, either in a Reference List before the claims, or in the text itself; and, each of these documents or references ("herein-cited references"), as well as each document or reference cited in each of the herein-cited references (including any manufacturer's specifications, instructions, etc.), is hereby expressly incorporated herein by reference. Documents incorporated by reference into this text may be employed in the practice of the invention.

FIELD OF THE INVENTION

[0003] The present invention relates generally to input and interaction techniques associated with flexible display devices.

BACKGROUND OF THE INVENTION

[0004] In recent years, considerable progress has been made towards the development of thin and flexible displays. U.S. Pat. No. 6,639,578 cites a process for creating an electronically addressable display that includes multiple printing operations, similar to a multi-color process in conventional screen printing. Likewise, U.S. Pat. Application No. 2006/0007368 cite a display device assembly comprising a flexible display device being rollable around an axis. A range of flexible electronic devices based on these technologies, including full color, high-resolution flexible OLED displays with a thickness of 0.2 mm are being introduced to the market (**14**). The goal of such efforts is to develop displays that resemble the superior handling, contrast and flexibility of real paper.

[0005] As part of this invention we devised an apparatus for tracking interaction techniques for flexible displays that uses a projection apparatus that projects images generated by a computer onto real paper, of which the shape is subsequently measured using a computer vision device. Deformation of the shape of the paper display is then used to manipulate in real time said images and/or associated computer functions displayed on said display. It should be noted that the category of displays to which this invention pertains is very different from the type of rigid-surface LCD displays cited in, for example, U.S. Pat. Nos. 6,567,068 or 6,573,883 which can be rotated around their respective axes but not deformed.

[0006] Prior art, which include bendable interfaces such as ShapeTape (**1**) and Gummi (**20**) demonstrates the value of incorporating the deformation of computing objects for use as input for computer processes. However, in this patent, we propose methods for interacting with flexible displays that rely on deformations of the surface structure of the display itself. While this extends work performed by Schwesig et al (**17**), which proposed a credit card sized computer that uses physical deformation of the device for browsing of visual information, it should be noted that said device did not incorporate a flexible material, and did not use deformation of the display. Instead, it relied on the use of touch sensors mounted on a rigid LCD-style display body.

[0007] The use of projection to simulate computer devices on three dimensional objects is also cited in prior art. SmartSkin (**18**) is an interactive surface that is sensitive to human finger gestures. With SmartSkin, the user can manipulate the contents of a digital back-projection desk using manual interaction. Similarly, Rekimoto's Pick and Drop (**16**) is a system that lets users drag and drop digital data among different computers by projection onto a physical object. In Ishii's Tangible User Interface (TUI) paradigm (**5**), interaction with projected digital information is provided through physical manipulation of real-world objects. In all of such systems, the input device is not the actual display itself, or the display is not on the actual input device. With DataTiles (**17**), Rekimoto et. al. proposed the use of plastic surfaces as widgets that with touch-sensitive control properties for manipulating data projected onto other plastic surfaces. Here, the display surfaces are again two-dimensional and rigid body.

[0008] In DigitalDesk (**24**), a physical desk is augmented with electronic input and display. A computer controlled camera and projector are positioned above the desk. Image processing is used to determine which page a user is pointing at. Object character recognition transfers content between real paper and electronic documents projected on the desk. Wellner demonstrates the use of his system with a calculator that blurs the boundaries between the digital and physical world by taking a printed number and transferring it into an electronic calculator. Interactive Paper (**11**) provides a framework for three prototypes. Ariel (**11**) merges the use of engineering drawings with electronic information by projecting digital drawings on real paper laid out on a planar surface. In Video Mosaic (**11**), a paper storyboard is used to edit video segments. Users annotate and organize video clips by spreading augmented paper over a large tabletop. Cameleon (**11**) simulates the use of paper flight strips by air traffic controllers, merging them with the digital world. Users interact with a tablet and touch sensitive screen to annotate and obtain data from the flight strips. Paper Augmented Digital Documents (**3**) are digital documents that are modified on a computer screen or on paper. Digital copies of a document are maintained in a central database and if needed, printed to paper using IR transparent ink. This is used to track annotations to documents using a special pen.

[0009] Insight Lab (**9**) is an immersive environment that seamlessly supports collaboration and creation of design requirement documents. Paper documents and whiteboards allow group members to sketch, annotate, and share work. The system uses bar code scanners to maintain the link between paper, whiteboard printouts, and digital information.

[0010] Xlibris (**19**) uses a tablet display and paper-like interface to include the affordances of paper while reading.